K3 Balanced forces

Learn about:

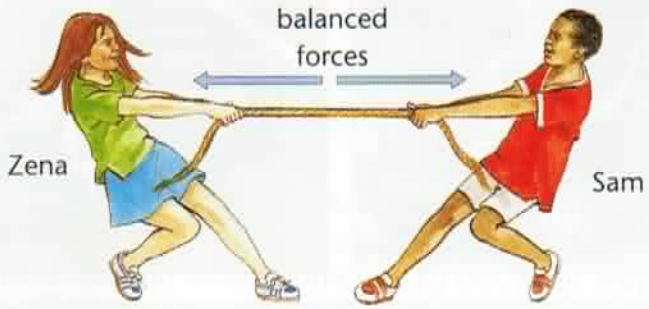
- Force arrows
- Balanced forces

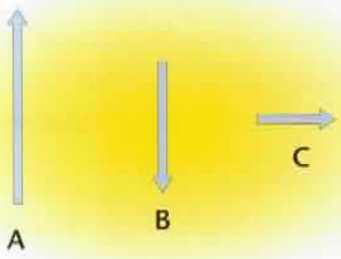
Do you remember?

An object stays where it is because the forces are balanced.

Staying put

Look at the picture of Zena and Sam having a tug-of-war. They are not moving. They are pulling with the same sized force, but in opposite directions. The forces are shown with **force arrows**. A force arrow points in the direction of the force. The length of the arrow shows the size of the force. If two forces are the same size and pull in opposite directions, the forces are **balanced**.



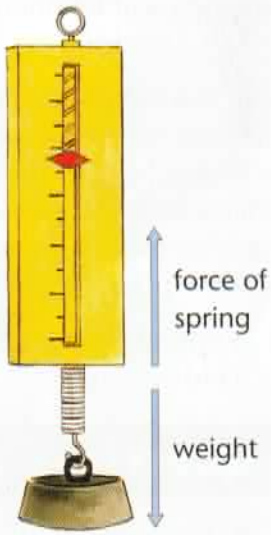


a **Which of the arrows A, B and C shows the biggest force?**

b **Which arrow shows the smallest force?**

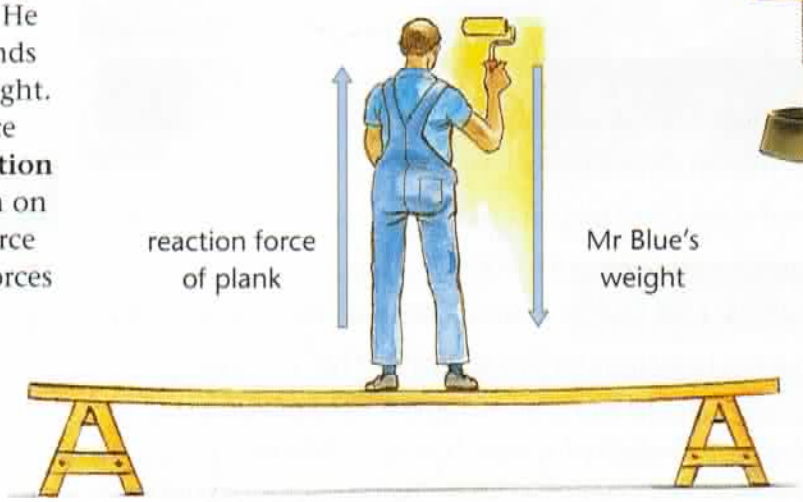
More balanced forces

The picture shows a mass hanging from a spring on a forcemeter. The mass is not moving. The spring has stretched. The amount it stretches is called the **extension**. The extension depends on how much mass is hung on the spring. The forces on it are balanced. Weight is the force pulling down on the spring with the same force as the spring pulls up on the mass.



If the weight is too heavy, the spring will be stretched out of shape. The spring does not return to its original shape when you take the mass off.

Mr Blue the decorator stands on a plank of wood to paint a wall. He stands very still. The plank bends down because of Mr Blue's weight. The plank pushes up. This force from the plank is called a **reaction force**. The force pushing down on the plank is the same as the force pushing up on Mr Blue. The forces are balanced. If they were not, the plank would break.



c **What are the forces on your chair when you sit still on it? Draw a diagram with arrows.**

d Look at the diagrams below. They all show situations where the forces are balanced on a non-moving object. Sketch each diagram and add the force arrows.

Why do things float and sink?

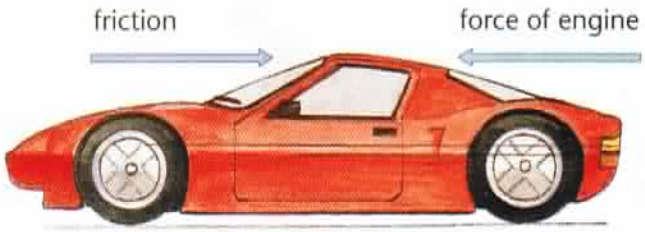
When you put an object into water, the water pushes up on the object. This force is called **upthrust**. If the object **floats**, then the upthrust is equal to weight. The forces are balanced. If the object **sinks**, then the upthrust and weight are not equal. The forces are unbalanced.

e **Draw a force diagram to show the forces on a floating boat.**

There are balanced forces on a hot-air balloon floating in air.

Steady speed

When you are travelling in a car at a steady speed, the forward forces are the same as the forces of friction acting against the car. The picture below shows this. The forces are balanced when the car is moving at a steady speed. So balanced forces don't just exist when an object is still. They can also exist when an object is moving at a steady speed.



Questions

1 Copy the sentences below and say whether you think the forces are balanced for each one.

- **a** A car travelling at a steady speed on a motorway...
- **b** A car speeding up to overtake a slow lorry...
- **c** A car parked at the roadside...

2 Name the force that balances your weight when you stand on a plank.

3 Julie and Jill pull on a rope with a joint force of 50 N in one direction, and Jack and Paulo pull in the opposite direction. If the forces are balanced, what force do Jack and Paulo exert?

4 Draw a force diagram showing the forces on an aeroplane travelling at a steady speed.

For your notes:

- If two forces are the same size and pull in opposite directions, they are called **balanced forces**.
- The **reaction force** stops something falling through a solid object. The reaction force balances the weight.
- When an object **floats**, the forces of weight and **upthrust** are equal. If the forces are unbalanced, the object **sinks**.
- When a car is moving at steady speed the forces are balanced.

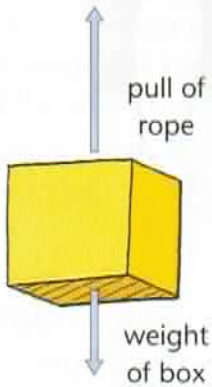
Learn about:

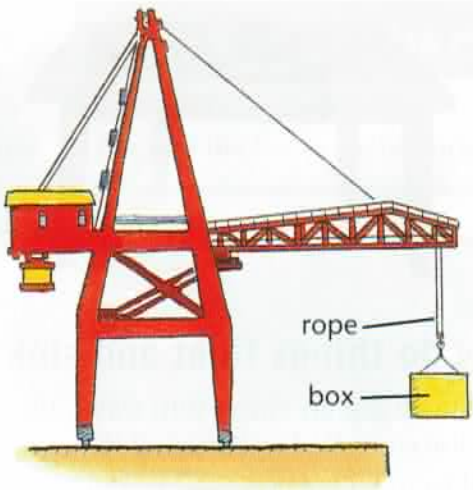
- Unbalanced forces

K4 Unbalanced forces

Unbalanced forces

The box in the picture has two forces acting on it. One is the pull of the rope. The other is the weight of the box. The force arrows are different lengths. This tells us that the forces are different sizes. They are called **unbalanced forces**.





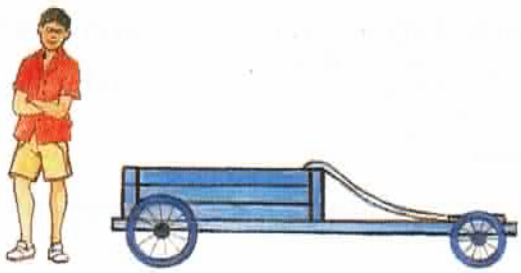
a **Which force is bigger?**

b **In which direction do you think the box will move?**

Getting going

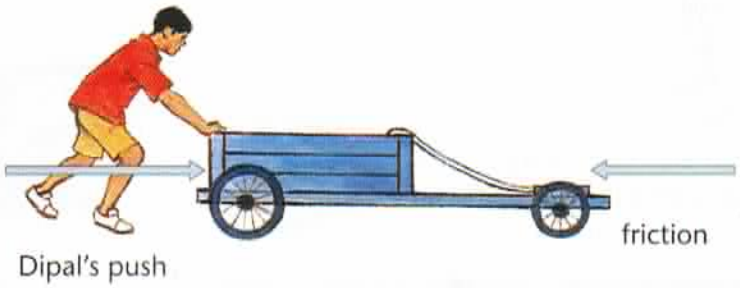
If Dipal does not push his go-kart, it will not start moving. A force is needed to start something moving.

Dipal gave his go-kart a gentle push. It did not move at all.



c **What force do you think stopped the go-kart moving?**

Dipal gave his go-kart a bigger push. Dipal's push on the go-kart was bigger than friction, so the go-kart started to move.



When forces push against each other like this, and one force is bigger than the other, they are unbalanced forces.

When there are unbalanced forces acting on an object, the object starts to move. It moves in the direction of the bigger force and it gets faster.

Calculating the size of the force

In this diagram, the forces are unbalanced. The big man will push the box towards the small man. We can work out the size of the force that pushed the box:

The size of the unbalanced force is sometimes called the **resultant force**. In this example the resultant force is 75 N.

100 N – 25 N = 75 N

Shaping up

Unbalanced forces can also change the shape of an object. It might become bent, twisted or even break.

d **Give an example of something which changes shape with unbalanced forces on it.**

Unbalanced forces on moving objects

Unbalanced forces can act on something that is already moving. The car in the diagram is moving forwards.

Air makes friction with moving objects such as cars and planes. We call this **air resistance**. Because the force from the engine is bigger than air resistance, the car moves faster.

e **The force from the engine is 1000 N, the force from air resistance is 50 N. What is the resultant force?**

When the bigger force is in the same direction as the movement, the object speeds up.

When the bigger force is in the opposite direction to the movement, the object slows down.

Unbalanced forces on moving objects can also make them change direction. If you are pushing a luggage trolley in a straight line and someone walks into it from the side, the trolley will change direction and move sideways.

Do you remember?

Air resistance is a force that slows down objects moving through air. Try walking into the wind!

Questions

1. What happens when there are unbalanced forces acting on an object that is not moving?
2. What happens to a moving object when there are unbalanced forces acting on it and the bigger force is in the same direction as the movement?
3. What happens to a moving object when there are unbalanced forces acting on it and the bigger force is in the opposite direction to the movement?
4. What might happen to a foam cushion when there are unbalanced forces acting on it?
5. Helen pushed a sledge with force of 8 N. The force of friction pushed against this with a force of 2 N. What is the resultant force?

For your notes:

- **Unbalanced forces** can act on an object that is not moving. The object starts to move in the direction of the bigger force.
- The size of the unbalanced force is called the **resultant force**.
- Unbalanced forces can also change the shape of an object.
- Unbalanced forces on a moving object can make the object speed up, slow down, or change direction.